CLAIMS

1. A method of making a lithography photomask blank, comprising the steps of:

providing a silicon oxyfluoride glass tube having an OH content less than 50 ppm,

cutting said silicon oxyfluoride glass tube,

flattening the silicon oxyfluoride glass tube, and

forming said flattened cut silicon oxyfluoride glass tube into a photomask blank having a planar surface.

2. A method as claimed in Claim 1, wherein providing a silicon oxyfluoride glass tube further includes providing a silicon oxyfluoride glass tube with a fluorine concentration greater than about 0.5wt.%.

3. A method as claimed in Claim 1, wherein providing a silicon oxyfluoride glass tube further includes providing a silicon oxyfluoride glass tube with a fluorine concentration in the range from about 0.5wt.% to about 2.5wt.%.

4. A method as claimed in Claim 1, wherein providing a silicon oxyfluoride glass tube further includes providing a silicon oxyfluoride glass tube with an OH content less than 5 ppm.

5. A method as claimed in Claim 1, wherein providing a silicon oxyfluoride glass tube further includes providing a silicon oxyfluoride glass tube with an OH content less than 1 ppm.

6. A method as claimed in Claim 1, wherein providing a silicon oxyfluoride glass tube further includes providing a SiO_2 soot tube, dehydrating the SiO_2 soot tube to remove OH from the SiO_2 soot, replacing a plurality of silicon to oxygen bonds with a plurality of silicon to fluorine bonds and consolidating the soot tube into a glass.

7. A method as claimed in Claim 1, further including depositing SiO_2 soot on a circular cross section support member.

8. A method as claimed in Claim 7, further comprising removing OH from said SiO_2 soot and incorporating fluorine into said SiO_2 soot.

9. A method as claimed in Claim 8 wherein removing OH from said SiO_2 soot includes heating said SiO_2 soot in a dehydrating atmosphere.

10. A method as claimed in Claim 9, wherein said dehydrating atmosphere includes chlorine.

11. A method as claimed in Claim 9, wherein said dehydrating atmosphere includes helium.

12. A method as claimed in Claim 9, wherein said dehydrating atmosphere includes fluorine.

13. A method as claimed in Claim 8 wherein incorporating fluorine into said SiO_2, soot comprises exposing said SiO_2 soot to an atmosphere containing fluorine.

14. A method as claimed in Claim 13 wherein said atmosphere containing fluorine includes SiF_4.

15. A method as claimed in Claim 13 wherein said atmosphere containing fluorine includes CF_4.

16. A method as claimed in Claim 13 wherein said atmosphere containing helium.

17. A method as claimed in Claim 8 wherein OH is first removed from the SiO_2 soot and then fluorine is incorporated.

18. A method as claimed in Claim 1 wherein providing a silicon oxyfluoride glass tube further comprises providing a glass tube that consists essentially of Si, O, and F.

19. A method as claimed in Claim 18 wherein said glass tube has a F wt. % concentration ranging from .5 to 3 wt. % and has an OH content less than 10 ppm.

20. A method as claimed in Claim 8 wherein removing OH from said SiO_2 soot includes heating said soot to a temperature in the range from 900 to 1100° C in an atmosphere containing Cl, incorporating fluorine into said SiO_2 soot includes heating said soot to a temperature in the range from 1125 to 1325° C in an atmosphere containing F, and then sintering said soot at a temperature in the range from 1350 to 1550° C. into said SiO_2 soot and consolidated into a glass so that said glass contains at least 0.5 wt. % F.

21. A method as claimed in Claim 1, wherein said silicon oxyfluoride glass tube has a longitudinal length and cutting said tube includes cutting said tube along said longitudinal length.

22. A method as claimed in Claim 1 wherein flattening the silicon oxyfluoride glass tube includes heating said tube and applying a deforming force to said heated tube.

23. A method as claimed in Claim 22 wherein applying a deforming force to said heated tube further comprises evacuting the heated tube to collapse said heated tube.

24. A method as claimed in Claim 22 further comprising, providing a flat sided mold, positioning said flat sided mold proximate said glass tube, applying a deforming fluid pressure force to the heated tube wherein said heated tube conforms to said flat sided mold.

25. A method as claimed in Claim 22 further comprising, further comprising, encompassing a mold with said tube and applying a collapsing fluid pressure deforming force to the heated tube wherein said tube collapses against said mold.

26. A method as claimed in Claim 22 further comprising: encompassing the silicon oxyfluoride tube with a mold and applying an expanding fluid pressure deforming force to the heated tube wherein said heated tube expands into said mold.

27. A method as claimed in Claim 26 wherein encompassing the tube with the mold further includes encompassing the tube with a flat sided mold.

28. A method as claimed in Claim 22 further comprising hanging the tube in a furnace heated to a temperature of at least 1480° C.

29. A method as claimed in Claim 22 further comprising sagging said tube in a furnace heated to a temperature centered about 1730° C so that said tube is flattened and flowout of said silicon oxyfluoride glass is substantially inhibited.

30. A method as claimed in Claim 21, wherein the tube is cut into at least two separate pieces.

31. A method as claimed in Claim 1 wherein providing a silicon oxyfluoride glass tube includes providing a tube that has an inside radius of at least 2.5 cm, a thickness of at least .6 cm, and a length of at least 15 cm.

32. A method as claimed in Claim 1 wherein providing a silicon oxyfluoride glass tube includes providing a tube that has an inside radius of at least 3.6 cm, a thickness of at least .6 cm, and a length of at least 22 cm.

33. A method as claimed in Claim 30, wherein providing a silicon oxyfluoride glass tube includes providing a tube that has an inside radius of at least 5 cm, a thickness of at least .6 cm, and a length of at least 15 cm.

34. A method as claimed in Claim 30, wherein providing a silicon oxyfluoride glass tube includes providing a tube that has an inside radius of at least 7.6 cm, a thickness of at least .6 cm, and a length of at least 22 cm.

35. A method as claimed in Claim 1, wherein providing a silicon oxyfluoride glass tube includes providing a silicon oxyfluoride glass tube that has concentric layers of striae and the method further includes maintaining the relative orientation of said layers of striae so that said layers of striae are parallel to said photomask blank planar surface.

36. A method as claimed in Claim 1, wherein forming into a photomask blank includes polishing said flattened cut silicon oxyfluoride glass tube.

37. A method as claimed in Claim 1, further comprising transmitting 157 nm wavelength light through said formed photomask blank.

38. A method as claimed in Claim 1, further comprising forming a lithographic image pattern on said photomask blank planar surface.

39. A method as claimed in Claim 38 further comprising impinging light including the 157 nm wavelength towards said photomask blank planar surface to form a projection image pattern and projecting the projection image pattern onto a radiation sensitive material.

40. A glass lithography mask preform comprising a longitudinal silicon oxyfluoride glass tube having an OH content ≤ .5 wt. %, said longitudinal tube having a central axis along the longitudinal length of said glass tube, wherein said glass tube includes concentric layers of striae centered about said central axis.

41. A glass lithography mask preform as claimed in Claim 40 wherein said longitudinal silicon oxyfluoride glass tube has a polygonal shape flat sided cross section.

42. A glass lithography mask preform as claimed in Claim 41 wherein said tube has a rectangular cross section.

43. A glass lithography mask preform as claimed in Claim 42 wherein said rectangular cross section tube has a square cross section.

44. A glass lithography mask preform as claimed in Claim 41 wherein said tube has a triangular cross section.

45. A glass lithography mask preform as claimed in Claim 41 wherein said tube has a pentagonal cross section.

46. A glass lithography mask preform as claimed in Claim 41 wherein said tube has a hexagonal cross section.

47. A glass lithography mask preform as claimed in Claim 40 wherein said silicon oxyfluoride glass tube having an inside radius of at least 2.5 cm, a thickness of at least .6 cm, a longitudinal length of at least 15 cm.

48. A glass lithography mask preform as claimed in Claim 40 wherein said silicon oxyfluoride glass tube consists essentially of Si, O, and F.

49. A glass lithography mask preform as claimed in Claim 40 wherein said silicon oxyfluoride glass tube has a 157 nm light transmission percentage of at least 70% per 5mm thickness of glass.

50. A glass lithography mask preform as claimed in Claim 40 wherein said silicon oxyfluoride glass tube has an inside radius of at least 3.6 cm and a longitudinal length of at least 22 cm.

51. A glass lithography mask preform as claimed in Claim 40 wherein said silicon oxyfluoride glass tube has an inside radius of at least 5 cm and a longitudinal length of at least 15 cm.

52. A glass lithography mask preform as claimed in Claim 40 wherein said silicon oxyfluoride glass tube has an inside radius of at least 7.6 cm and a longitudinal length of at least 22 cm.

53. A glass lithography mask preform as claimed in Claim 40 wherein said silicon oxyfluoride glass tube surrounds a silica glass tube.

54. A glass lithography mask preform as claimed in Claim 40 wherein said glass tube has a transmission homogeneity at 157 nm in the range from –2% to +2%.

55. A glass lithography mask preform as claimed in claim 40 wherein said glass tube is free of inclusions having a dimension > 1 μm.

56. A glass lithography mask preform as claimed in claim 40 wherein said glass tube has a birefringence ≤ 5 nm/cm.

57. A lithography photomask blank comprising a flat planar silicon oxyfluoride glass member having a top planar surface and a bottom planar surface, said planar silicon oxyfluoride glass member having an OH content ≤

10 ppm, a F wt. % concentration ≥ .5 wt. %, said silicon oxyfluoride glass having parallel layers of striae wherein said parallel layers of striae are parallel to said top planar surface.

58. A lithography photomask blank as claimed in claim 57, wherein said top planar surface has a surface roughness ≤ 0.15 nm rms.

59. A lithography photomask blank as claimed in claim 57, wherein said planar silicon oxyfluoride glass member has a 157 nm light transmission percentage of at least 70% per 5 mm thickness of glass.

60. A lithography photomask blank as claimed in claim 57 wherein said silicon oxyfluoride glass consists essentially of Si, O, and F.

61. A lithography photomask blank as claimed in claim 57 wherein said silicon oxyfluoride glass has a F wt. % content in the range from .5 wt. % to 3 wt. %.

62. A lithography photomask blank as claimed in claim 57 wherein said flat planar silicon oxyfluoride glass member has a transmission homogeneity at 157 nm in a range from –2%to +2%.

63. A lithography photomask blank as claimed in claim 57 wherein said flat planar silicon oxyfluoride glass member is free of inclusions having a dimension > 1 μm.

64. A lithography photomask blank as claimed in claim 57 wherein said flat planar silicon oxyfluoride glass member has a birefringence ≤ 5 nm/cm.

65. A lithography photomask blank as claimed in claim 57 wherein said flat planar silicon oxyfluoride glass member has a thickness of at least .6 cm, a length of at least 15 cm, is free of inclusions having a dimension > 1 μm, a

transmission homogeneity at 157 nm in the range from –2% to +2%, transmission at 157 nm > 70%, and a birefringence ≤ 5 nm /cm.

66. A glass lithography mask preform for forming a lithography mask having a mask width MW, a mask length ML, and a mask thickness MT, said glass lithography mask preform comprising a glass tube with an inside radius IR, a thickness T, a length L, and a longitudinal center tube axis CA, wherein said glass tube includes concentric layers of striae centered about said center axis CA, IR ≥ (7/44)MW, T > MT, and L ≥ ML.

67. A preform as claimed in claim 66 wherein said glass tube is comprised of a silicon oxyfluoride glass.

68. A preform as claimed in claim 67 wherein said silicon oxyfluoride glass has an OH content ≤ 10 ppm.

69. A lithography mask formed from a glass lithography mask preform as claimed in claim 66, wherein said lithography mask is comprised of a flat planar glass member having a top planar surface, a bottom planar surface, a mask width of MW, a mask length of ML, and a mask thickness of MT, wherein said flat planar glass member includes parallel layers of striae which are parallel to said top planar surface and said bottom planar surface.

70. A method of making a mask comprising the steps of:

providing a glass tube mask preform having an inside radius IR, a thickness T, a length L, a longitudinal center tube axis CA, and said glass tube mask preform includes concentric layers of striae centered about said center axis CA, flattening said glass tube mask preform into a flat planar glass mask having a top planar surface and a bottom planar surface, wherein said flat planar glass mask has parallel layers of striae that are parallel to said top planar surface and said bottom planar surface.

71. A method as claimed in claim 70, wherein flattening includes cutting said glass tube mask preform along said length L and in alignment with said axis CA and polishing said top planar surface and said bottom planar surface.

72. A method as claimed in claim 70, wherein flattening includes flattening said glass tube mask preform into said flat planar mask with said flat planar mask having a mask width MW, a mask length ML, and a mask thickness MT, wherein $MW \leq (44/7)IR$, $MT < T$, and $ML \leq L$.

73. A method as claimed in claim 70 wherein flattening includes flattening said glass tube mask preform into said flat planar mask with said flat planar mask having a mask width MW, a mask length ML, and a mask thickness MT, wherein $MW \leq (22/7)IR$, $MT < T$, and $ML \leq L$.

74. A method as claimed in claim 70 wherein flattening includes flattening said glass tube mask preform into said flat planar mask with said flat planar mask having a mask width MW, a mask length ML, and a mask thickness MT, wherein $MW \leq (44/21)IR$, $MT < T$, and $ML \leq L$.

75. A method as claimed in claim 70 wherein flattening includes flattening said glass tube mask perform into said flat planar mask with said flat planar mask having a mask width MW, a mask length ML, and a mask thickness MT, wherein $MW \leq (11/7)IR$, $MT < T$, and $ML \leq L$.

76. A method as claimed in claim 70 wherein flattening includes deforming said glass tube against a mold having a flat planar side.

77. A method as claimed in claim 70 further comprising providing said flat planar sided mold with a square cross section, encompassing said glass tube with said square cross section mold, expanding said glass tube into said square cross section mold wherein said expanded glass tube has a square

cross section, cutting at least one side from said square cross section expanded glass tube to provide said flat planar glass mask.

78. A method as claimed in claim 70 further comprising encompassing said flat planar sided mold with said glass tube, collapsing said glass tube onto said flat planar side wherein said collapsed glass tube has a flat planar side, cutting said flat planar sided collapsed glass tube to provide said flat planar glass mask.

79. A method as claimed in Claim 70 wherein flattening includes heating said glass tube, and evacuating and collapsing said heated glass tube.

80. A glass blank preform comprising a longitudinal glass tube having a longitudinal length, a polygonal cross sectional shape and a central axis along a longitudinal length and normal to said polygonal cross sectional shape, said glass tube having concentric layers of striae centered about said central axis.

81. A glass blank preform as claimed in claim 80 wherein said glass tube is comprised of a silica glass.

82. A glass blank preform as claimed in claim 80 wherein said glass tube is comprised of silicon oxyfluoride glass.

83. A glass blank preform as claimed in claim 80 wherein said glass tube is substantially free of OH.

84. A glass blank preform as claimed in claim 80 wherein said glass tube is substantially free of Cl.

85. A glass blank preform as claimed in claim 80 wherein said glass tube is substantially free of H_2.

86. A glass blank preform as claimed in claim 80 wherein said polygonal cross sectional shape is square.

87. A method of making a glass blank, said method comprising:

providing a longitudinal glass tube,

providing a longitudinal mold having a flat sided polygonal shape,

positioning said longitudinal glass tube proximate said longitudinal mold,

heating said longitudinal glass tube,

applying a deforming fluid pressure to said heated longitudinal glass tube wherein said glass tube deforms and conforms to said mold,

cooling said deformed glass tube to provide a flat sided polygonal shaped glass tube, and

cutting a flat side from said flat sided polygonal shaped glass tube.

88. A method of making a glass blank as claimed in claim 87, wherein providing a longitudinal glass tube further includes providing a SiO_2 soot tube and consolidating the soot tube into a glass.

89. A method of making a glass blank as claimed in claim 87, wherein providing a longitudinal glass tube further includes depositing SiO_2 soot on a support member.

90. A method of making a glass blank as claimed in claim 87, wherein providing a longitudinal glass tube further includes providing a silicon oxyfluoride glass tube.

91. A method of making a glass blank as claimed in claim 87, wherein providing a longitudinal glass tube further includes providing a glass tube comprised of silicon dioxide.

92. A method of making a glass blank as claimed in claim 87, wherein providing a longitudinal glass tube further includes providing a high purity fused silica glass tube.

93. A method of making a glass blank as claimed in claim 87, further comprising encompassing said glass tube with said mold and expanding said glass tube into contact with said mold.

94. A method of making a glass blank as claimed in claim 87, further comprising encompassing said mold with said glass tube and collapsing said glass tube onto said mold.

95. A glass blank preform for forming a blank having a blank width MW, a blank length ML, and a blank thickness MT, said glass preform comprising a flat sided glass tube with a thickness T, a length L, a flat sided height H and a longitudinal center tube axis CA, wherein said glass tube includes concentric layers of striae centered about said center axis CA, $H \geq MW$, $T \geq MT$, and $L \geq ML$.

96. A preform as claimed in claim 95 wherein said glass tube is comprised of a silicon oxyfluoride glass.

97. A preform as claimed in claim 95 wherein said glass tube has an OH content ≤ 10 ppm.

98. A preform as claimed in claim 95 wherein said glass tube is comprised of silicon dioxide.

99. A preform as claimed in claim 95 wherein said glass tube is comprised of a high purity fused glass.

100. A blank formed from a glass blank preform as claimed in claim 95, wherein said blank is comprised of a flat planar glass member having a top planar surface, a bottom planar surface, a blank width of MW, a blank length of ML, and a blank thickness of MT, wherein said flat planar glass member includes parallel layers of striae which are parallel to said top planar surface and said bottom planar surface.

101. A method of making a photomask blank, said method comprises:

providing a silicon oxyfluoride glass tube;

heating said glass tube;

evacuating said heated glass tube to collapse said glass tube into a flattened collapsed tube;

forming said flattened collapsed tube into a photomask blank.

102. A method of making a low OH silicon oxyfluoride glass blank said method comprising

providing a SiO_2 soot

exposing said soot to a chlorine containing atmosphere to remove OH from said soot

terminating exposure to said chlorine atmosphere

flushing residual chlorine from the soot

consoilidating said soot into a silicon oxyfluoride glass having an OH level less that 1 ppm.

103. A method as claimed in claim 102 wherein flushing and consolidating comprises flushing and consolidating said soot in a He containing atmosphere.

104. A method as claimed in claim 102 wherein flushing and consolidating comprises flushing and consolidating said soot in a F containing atmosphere.